

NUMERICAL CHARACTERIZATION OF PARTICLE DISPERSION IN THE TURBULENT RECIRCULATION ZONES OF SUDDEN EXPANSION PIPE FLOWS

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Introduction

The dispersion of solid particles in the turbulent recirculation zones of sudden expansion pipes can be characterized by different Stokes numbers and mean drift parameter and its study is important because this kind of flows appears in many technological applications. Many experimental studies have been developed in order to know the contribution of Stokes numbers [1][2] and mean drift parameter [3] on the entering and dispersion of particles in recirculation zone however to our knowledge there are not numerical studies reported about it. Our work has been to: a) simulate the incompressible and turbulent flow in sudden expansion pipes with different step sizes ($H_1=2$, $H_2=2.5$) and different Reynolds number in upstream pipe ($Re_{b1}=10600$, $Re_{b2}=14000$) using LES and Germano dynamic model with JetCode program [4] ; b) use a Lagrangian tracking algorithm coupled to JetCode to solve solid particles ($d_{p1}=60\text{ }\mu\text{m}$, $d_{p2}=150\text{ }\mu\text{m}$, movement equations taking into account only drag and gravity and supposing one way coupling; c) calculate Stokes numbers based on the fluid time scales (T) corresponding to large eddy ($St_e = (T_e/\tau_p)$), transit along the recirculation zone ($St_{tr} = (T_{tr}/\tau_p)$) and centrifugal $St_\omega = (T_\omega/\tau_p)$ and mean drift parameter ($\gamma_{mean} = v_T/U_n$) for all resolved cases and study their isolated effect on the particle dispersion in the recirculation zones by computing concentration (C) by means of the particle number within the recirculation zone (Np_r).

Results

The results are shown in Table 1. In cases 1 and 3, $St_e \approx 0(1)$, $St_{tr} > 1$, $St_\omega > 1$ and C exhibits a maximum value which coincides with the experimental findings of [1] and simultaneously $\gamma_{mean} < 1$. However, in cases 5 and 7 only holds that $\gamma_{mean} < 1$ and C shows an increment coinciding with the results of [3].

Case	St_e	St_{tr}	St_ω	γ_m	$C=Np_r/Np_{Caso6}$
1 (Re ₁ H ₁ d ₁)	5.10	11.5	44.4	0.38	8.4
2 (Re ₁ H ₁ d ₂)	0.62	1.40	5.41	3.11	2.4
3 (Re ₁ H ₂ d ₁)	6.40	23.4	82.6	0.44	11.7
4 (Re ₁ H ₂ d ₂)	0.77	2.85	10.1	3.63	4.1
5 (Re ₂ H ₁ d ₁)	0.46	0.90	3.07	0.11	1.1
6 (Re ₂ H ₁ d ₂)	0.06	0.11	0.37	0.91	1
7 (Re ₂ H ₂ d ₁)	0.78	1.33	4.46	0.14	1.7
8 (Re ₂ H ₂ d ₂)	0.09	0.17	0.54	1.15	1.5

Conclusions

We had developed a numerical study of turbulent flow laden with solid particles in a sudden expansion pipe in order to characterize particle dispersion in recirculation zone. We found that the effect of increasing mean parameters was to reduce the tendency of particles to enter recirculation zone.

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